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Impacts of Information Systems on Efficiency of Sales Order Processing

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Abstract

Since the sales order processing function is essential to the generation of the firm's revenue, its efficiency may be measured by a productivity index representing the firm's revenue, preferably value-added revenue, per unit of its inputs. This index enables one to evaluate economic impacts of an information system on the function. In the past, information systems have helped to enhance the productivity of the function as they have evolved in steps by incorporating advances in computer technology into their design. The evolution mainly concerns how order data are prepared and entered into the computer system. Two cases are presented to illustrate such productivity enhancements.

Impacts of Information Systems on Efficiency of Sales Order Processing

Introduction

The main purpose of the office is to perform functions essential to the operation of the firm, such as accounting, finance, sales and marketing, purchasing, administrative and personnel. Sales order processing is a subfunction of the sales and marketing function and regarded by most firms as one of the priority office areas for computerization, because the fast and accurate processing of customer orders is believed to have direct positive effects on customer satisfaction.

One commonly used method of selecting a particular information system is first to find a few alternative systems that satisfy user reqirements and organizational constraints, and then to select a particular one from the alternatives through an economic feasibility study. This study usually is the marginal cost/benefit analysis that takes into consideration only those costs which are above or below the comparable costs of the existing system.

The objective of using an information system usually is to enhance the efficiency of an office function. Management would naturally be interested in assessing an increase in the efficiency by the implementations of the information system, or comparing the efficiency of an office function of their firm with the efficiences of the same function of competitors. These comparisons are possible with the productivity measures of the office functions involved.

Productivity Measures of the Office Function

Economists have been interested in measuring the productivity of an economy or an industrial sector and developed methods for the measurement. Concepts underlying these methods are also useful to the measurement of office productivity.

Early on, the most widely used index of productivity was the physical output per manhour. Commonly used productivity measures at present are the total factor productivity (TFP) ratio (output per unit of all inputs) and partial factor productivity ratios (outputs per unit of major factors of input). While useful for evaluating the change in efficiency of production of the economy, TFP is limited in its usefulness at the level of the firm because its output normally represents the gross revenue from output, the cumulative result of production by various firms through the firm under consideration.

A better alternative to the productivity based on the gross revenue is the "value-added" productivity, the productivity based on the value-added revenue. The value-added revenue of the firm is the gross revenue from output minus the cost of all materials and services acquired from outside. This productivity measure has another merit for management in that it is sensitive to the amount of input and therefore useful in evaluating the efficiency of an office function. According to Greenberg (1973), the value-added-per-manhour ratio can have great variations among firms in the same industry, on the average as much as five times in the ratio between the "best" 25 percent and the lowest 25 percent.

Partial factor productivity measures show the efficiencies of major cost factors such as labor, cost of materials and contractual services, capital cost (interest, rents, royalties, and profit before taxes), and indirect business taxes (Kendrick and Creamer, 1961). They reflect changes in input-mix resulting from factor substitutions, as well as technological advances and other forces impinging on production efficiency (Kendrick and Grossman, 1980).

The labor productivity ratio measures most commonly output per labor hour. This ratio is usually subject to upward bias, because it fails to take into account not only capital but change in the composition or quality of labor (Fabricant, 1959; Kendrick and Grossman, 1980). In the office, the information system is substitutable to labor, playing a role similar to capital equipment used in production. Denison (1974) states that "Advances in knowledge" relevant to production enhances the output obtained from a given quantity of resources, and is the biggest and most basic reason for the persistent long-term growth of output per unit of input. His remarks are also valid for advances in information systems technology which have greatly enhanced the producutivity of the office.

Productivity per manhour is a meaningful measure for an office function performed by clerks of the same skill. Where different skills are involved, their manhours should be adjusted to those of a standard skill with proper weights assigned to them. Different types of inputs should be represented by their costs. If an office function processes only one type of business form or data item throughout the

day, spending approximately the same amount of time per form or item, its output may be given by the number of forms or data items processed. In these cases, the productivity of the office function may be represented by one of the following two pairs of measures, (p,P) or (q,Q):

(1) A constant time assumed for processing a document:

$$p = \frac{N}{M} \qquad \text{(documents/manhour)} \qquad (1)$$

$$P = \frac{N}{C} \qquad \text{(documents/resource dollar)} \qquad (2)$$

(2) A constant time assumed for processing a data item:

$$q = \frac{D}{M} \qquad \text{(data items/manhour)} \qquad (3)$$

$$Q = \frac{D}{C} \qquad \text{(data items/resource dollar)} \qquad (4)$$

where N = the number of documents processed by the office function per day

D = the number of data items processed by the office function per day

M = the number of manhours worked for the office function per day

C = the total cost of resources used by the office function per day

The restrictive assumptions imposed on producutivity measures in (1)-(4) limit the use of these measures. There is a need for other measures that are less restrictive. An office function such as sales order processing is essential to the generation of revenue. Therefore,

its productivity may appropriately be measured by the revenue, preferably value-added revenue, of the firm per unit of its input. This productivity measure may be called the "function productivity." Since the function productivity is independent of such attributes as business form, data item, product, and business, it has a wide applicability to in-house or inter-organizational efficiency comparisons. This productivity may be given by the following two measures, r and R:

(3) No assumption on processing time:

$$r = \frac{V}{M} \quad \text{(dollars of value-added revenue/manhour)} \quad (5)$$

$$R = \frac{V}{C} \quad \text{(dollars of value-added revenue/resource dollar)} \quad (6)$$

where V = the value-added revenue of the firm per day

Information Processing Systems for Sales Order Processing

Even before the emergence of computers in the mid-50s, some firms were processing sales orders by a mechanized system using punched card equipment. For most firms, however, the computerization of the sales order processing function took place during the 1960s. Until then, they used a system consisting of all manual operations to perform the function. Since the initial use of a computerized information system, the order processing function has gone through evolutionary changes in its structure as more advanced information systems have been implemented and gradually replaced manual activities. The evolution is

mainly related to how order data are prepared and entered into the computer system, and can be divided into the following four stages:

Stage 1. Manual data processing

Stage 2. Off-line data preparation

Stage 3. On-line data entry

Stage 4. Data entry at sources.

In Table 1 are listed the major manual and computer-related operations included in the function at each of the above stages. The main operations of and input resources used for the function in each stage are discussed below.

(1) Stage 1: Manual data processing

All activities of the order processing function in this stage are manual. Typically, clerks receive sales orders from customers, transcribe order data onto order forms, check inventories, write shipping orders, and distribute the shipping orders to the warehouse. Since all activities involve similar low manual skills, computing the productivity of the function in terms of output per manhour seems meaningful.

If no capital equipment is used, the total cost of resources used per day consists mainly of the wages paid to the clerks and the cost of supplies, and is given by the following C:

$$C = \begin{array}{l}\text{Wages Paid to}\\ \text{Order-Entry}\\ \text{Clerks}\end{array} + \begin{array}{l}\text{Cost of}\\ \text{Supplies}\end{array} \qquad \text{(dollars/day)} \qquad (7)$$

(2) Stage 2: Off-line data preparation

In this initial use of computers in order processing, the order entry clerk usually writes in an order form with only those data that are variable with the order, such as customer account number, ordered items, ordered quantities, and special instructions. All other data necessary for shipping and invoicing are retrieved from the online product and customer master files when the sales order is processed by the computer.

A typical sequence of activities in this stage are:

1. Clerks receive sales orders from customers, and transcribe order onto order forms.
2. Keypunchers punch out cards with data on the forms.
3. The computer reads data on the cards, checks the inventories of ordered items, and prints out shipping orders.
4. Clerks distribute the shipping orders to the warehouse.

In this case, inputs to the function include the activities of order entry clerks, keypunchers, and the portion of the computer center resources applicable to the function. Because a variety of skills are involved, the function productivity in terms of output per manhour is not meaningful. The total daily cost of resources used for the function is given by the following C:

$$C = \begin{array}{c}\text{Wages paid}\\ \text{to Order-entry}\\ \text{Clerks}\end{array} + \begin{array}{c}\text{Cost of}\\ \text{Keypunching}\\ \text{Operation}\end{array} + \begin{array}{c}\text{Equivalent Daily}\\ \text{Cost of System}\\ \text{Development}\end{array}$$

$$+ \begin{array}{l}\text{Computer Center}\\ \text{Cost Applicable}\\ \text{to Function}\end{array} \qquad \text{(dollars/day)} \qquad (8)$$

The cost of keypunching operation consists of wages paid to keypunchers and the rental of keypunch machines. The information system development cost includes the costs of system analysis, design, testing and implementation, special software and hardware if required, office renovation, retraining personnel, reallocation of surplus personnel, etc. Like the cost of capital equipment investment, the capitalized cost of information system development should be allocated to each year of the estimated life of the system in determining the total daily cost of resources used. Where a constant use of the system is assumed, the annual allocation is given by an equivalent annual cost determined as follows:

$$E = \left\{\frac{i(1+i)^n}{(1+i)^n - 1}\right\} S \qquad \text{(dollars/year)} \qquad (9)$$

where E = equivalent annual cost charged at the end of each year (dollars)

S = total capitalized cost of system development (dollars)

i = annual rate of return expected from investment projects (fraction)

n = expected life of the system (years)

The equivalent annual cost in (9) must further be adjusted to a daily equivalent before being used in the total cost C in (8).

Finally, the computer center resources--including the computer center personnel, hardware, and system software--must be allocated to the order processing function. If the firm keeps the accounting records of the total CPU time, total I/O time, auxiliary storage capacity, etc. used for the order processing application, these records are

used to determine the total cost of computer center resources applicable to the function. In a simple but less accurate way, the total cost of resources may be allocated to the function according to the fraction of the total CPU time used by the order processing application. These methods of allocation are applicable to stages 3 and 4, also.

(3) Stage 3: On-line data entry

Since around 1970, many organizations have been entering data into a computer system through an on-line terminal without going through the keypunching operation of stage 2. In this arrangement, the transaction data thus entered into the computer system are either accumulated in an on-line file for later batch processing or processed on a real-time basis. Usually, great savings in labor cost are realized by a system conversion from stage 2 to stage 3 due to two reasons: (1) a great reduction in order processing clerks because of the replacement of the tedious form-writing work by the fast keying operation, and (2) the elimination of needs for keypunchers and other personnel associated with the order processing function.

The order processing function in this stage usually consists of the following activities:

1. Clerks receive sales orders from customers and enter data on these orders into the computer system through an online terminal.

2. The computer checks the inventories of ordered items, and prints out shipping orders through an online printer at the warehouse.

If the same clerk performs both order-receiving and order-entry operations, productivity measures in terms of output per manhour are

meaningful. The total cost of resources used in this stage is given by the following C:

$$C = \begin{matrix}\text{Wages paid}\\ \text{to Order-entry}\\ \text{Clerks}\end{matrix} + \begin{matrix}\text{Rental of}\\ \text{Order-entry}\\ \text{Terminals}\end{matrix} + \begin{matrix}\text{Equivalent Daily}\\ \text{Cost of System}\\ \text{Development}\end{matrix}$$

$$+ \begin{matrix}\text{Computer Center}\\ \text{Cost Applicable}\\ \text{to Function}\end{matrix} + \begin{matrix}\text{Cost of Data}\\ \text{Transmission}\\ \text{to Warehouse}\end{matrix} \quad \text{(dollars/day)} \qquad (10)$$

(4) Stage 4: Data entry at sources

In computerizing the business function, the greatest labor savings are possibly achieved by letting sources originating transactions enter their data into the computer system. Connecting the source of data with the host computer eliminates needs for human intervention between the two points. Since the mid-1970s, some progressive firms have been using this type of system for sales order processing, eliminating needs for the manual operations performed by order-receiving and order-entry clerks in stage 3. A typical sequence of activities in this stage is as follows:

1. Customers enter sales order data into their terminals and send the data to the vendor's host computer through transmission lines.

2. The vendor's computer receives the order data, checks the inventory file of the distribution center closest to each customer, and prints out a shipping order through an online terminal at the distribution center.

In this stage, the entire operations of the order processing function is computerized. The work of writing purchase orders by the customer is replaced by the on-line order-entry work which usually results in labor cost savings for the customer. A new cost to be

incurred in this stage is that of data transmission between the data-entry point and the vendor's computer. The total cost of resources used in this stage is as follows:

$$C = \begin{array}{c}\text{Cost of}\\ \text{Data-entry}\\ \text{at Sources}\\ \text{(if necessary)}\end{array} + \begin{array}{c}\text{Cost of Data}\\ \text{Transmission from}\\ \text{Sources to Host}\\ \text{Computer}\end{array} + \begin{array}{c}\text{Equivalent Daily}\\ \text{Cost of System}\\ \text{Development}\end{array}$$

$$+ \begin{array}{l}\text{Computer Center}\\ \text{Cost Applicable}\\ \text{to Function}\end{array} + \begin{array}{l}\text{Cost of Data}\\ \text{Transmission}\\ \text{to Distribution}\\ \text{Center}\end{array} \quad \text{(dollars/day)} \qquad (11)$$

When order data entered at sources in stage 4 are formatted differently from those entered by order-entry clerks in stage 3, the gross or value-added revenue is the only output measure useable for comparing the efficiency of the function in stage 3 with that efficiency in stage 4.

Illustrative Cases

Two cases are discussed to illustrate the use of the productivity measures and cost factors discussed above.

Case 1

In the mid-70s, a large gas utility converted a manual-batch processing system for processing customer orders in stage 2 to an online real-time processing system in stage 3 (Hinomoto, 1979). In the previous system, 154 business representatives were divided to 22 groups of seven each who sat around a circular work station with a rotating card file of customer master records. Each station had a unique telephone number and handled a block of customer names. An incoming call

on customer order was picked up by any free business representative at the station. However, about half the customers dialed a wrong number, and misdialed calls were transferred to the correct stations by three switchboard operators.

On picking up a correct call, the business representative asked for name and account number, located the customer's master card, and wrote on an order form the customer name, address and account number from the master card, the type of order, the date and time. Completed forms were accumulated until the end of the business when the originals of completed orders were sorted and forwarded to field service shops by messengers. Copies were sent to the computer center for key-punching, and punched cards thus produced were batch processed for updating the current order file.

In the new system, one phone number was assigned to all business representatives independent of the customer. All incoming calls were received by an automatic call distributor. The business representative had direct access to customer premise and account data from an online file, entered the order data directly into the information system, and could make immediate correction of errors in the entered data.

The system conversion enabled the company to reduce the number of business representatives from 154 to 103 and the number of other clerks from 91 to 63 in the sales division, and to eliminate needs for 14 key-punchers and one clerk at the computer center. In total, the system conversion reduced the number of personnel from 260 to 166, the details of which are shown in Table 2. Table 3 lists the elements of the initial cost incurred for the development and implementation of the new

system. Computers at this company were leased under a full-payment financial lease over a period of 6 years. Table 4 lists the base rental, maintenance cost and taxes related to computer equipment, the rental cost of other equipment, labor costs, and costs of forms and supplies with regard to the two systems.

The system conversion affected the skills required of personnel in the function, but it did not affect the wages of the personnel nor the order data to be processed. Despite the decrease in personnel, the system conversion enabled to increase the number of sales orders processed per day from 6,500 under the previous system to 7,000 under the new system, on the average. To compare the efficiencies of the function before and after the conversion, the number of sales orders processed per manhour and those per dollar of resources are computed, assuming 256 working days per year and using a capital recovery factor of 0.2163 based on a discount rate of 8%, the rate the company used for capital investment in those years, and a service life of six years:

(1) The manual-batch system

$$p_1 = \frac{6,500}{260 \times 8} = 3.12 \qquad \text{(sales orders/manhour)}$$

$$P_1 = \frac{6,500 \times 256}{4,404,898} = .378 \qquad \text{(sales orders/resource dollar)}$$

(2) The online system

$$p_2 = \frac{7,000}{166 \times 8} = 5.27 \qquad \text{(sales orders/manhour)}$$

$$P_2 = \frac{7,000 \times 256}{3,756,096 + 1,996,000 \times 0.2163} = .428$$

(sales orders/resource dollar)

Based on each type of productivity measure obtained above, the productivity improvement is computed as follows:

(1) In number of sales orders per manhour

$$\frac{P_2 - P_1}{P_1} = \frac{5.27 - 3.12}{3.12} = 69\%$$

(2) In number of sales orders per resource dollar

$$\frac{P_2 - P_1}{P_1} = \frac{.428 - .378}{.378} = 13\%$$

The above comparison shows an interesting result. While the output per manhour shows an impressive increase of 69%, the output per dollar of resources used shows a modest increase of 13%.

Case 2

This case concerns a Japanese producer of consumer disposable goods which sold its products to 240,000 retailers through 100 distributors. In 1975, the company started the conversion of its sales order processing system using online data-entry in stage 3 to a system receiving data from sources in stage 4. The conversion was carried out in steps between 1975 and 1980. To assess the productivity impacts of the system conversion as accurate as possible, data has been collected of the company's operation in 1975, just before the conversion, and in 1981, just after the completion of the total conversion.

In the previous system, 21 clerks received sales orders from distributors by telephone and wrote the orders on forms. Fourteen keyboard operators keypunched data on the forms onto paper tapes which were later hung on a paper-tape reader to send the data to a Univac 1106. A total of 12 clerks were engaged in distribution operations, who were later affected by the system conversion. In 1975, a total of 153,624 sales-order forms with 395,136 items were processed by the system, generating a gross revenue of $593 million.

The new system was a computer network in which a minicomputer installed at each distributor was connected with the host computer, a Univac 1100/81, at the producer's computer center. In a radical departure from the traditional arrangement, the producer leased the distributor's warehouse to maintain its own inventory. Each time the distributor shipped ordered items to a retailer, its clerk entered their quantities into the minicomputer system through an online terminal. The quantities shipped were accumulated in a sales transaction file during the business hours, at the end of which they were summed up by product and transmitted to the host computer. The host computer used the summary sales data thus received to update the distributor's inventory file kept in its system. If the inventory of an item dropped below a minimum acceptable level, the host computer automatically generated a shipping order to replenish the distributor's inventory.

The new system eliminated the needs for practically all order receiving and data-entry clerks at the producer's office. Consequently, the system conversion resulted in a reduction in the number of clerks engaged in order receiving and distribution operations from 51 to 34

and an elimination of 13 data-entry clerks. In Table 5 are listed the types and numbers of personnel required for the two systems.

Besides the reduction in labor force, other benefits became available with the system conversion. The lead time required to ship out merchandise to the distributor after receiving an order had been reduced from one full day under the previous system to a half day under the new system. Previously, the producer subscribed the Nielsen Market Survey to receive information on the two-months-old market condition. With the new system, it could get the retailers' daily demands on the same day. This helped improve inventory control and facilitate more realistic production scheduling. As a result, the rate of stockouts was decreased from about 3% to about 1.4% without increasing the general level of inventory.

The system conversion changed the format in which order data were entered into the computer system. Under the previous system, this producer received on the average 591 orders with 1520 items a day. With the new system, there was no explicit order. Instead, the total quantity sold for each item transmitted from the distributor's computer to the producer's host computer automatically became a sales order as well as an invoice. To evaluate the impacts of the system conversion in this case, the number of sales orders or ordered items was not a meaningful measure of output, but the revenue was. Since data on the value-added revenues in 1975 and 1981 were not available, data on the gross revenues in these years have been used in determining a productivity enhancement. In Table 6 are listed the gross revenues and costs of order-processing and distribution operations in 1975 and 1981.

The efficiency of the order processing function with each system is determined by two productivity measures, revenue per manhour and revenue per dollar of resources used. The former is much weaker as a productivity measure than the latter because of the involvement of different skills, nevertheless it is an interesting measure for comparison. The following productivity calculations are based on the assumption that there are 256 working days of 8 hours each per year:

(1) The online data-entry system

$$r_1 = \frac{593,234,000}{64 \times 256 \times 8} = 4,526 \qquad \text{(revenue dollars/manhour)}$$

$$R_1 = \frac{593,234,000}{1,133,000} = 524 \qquad \text{(revenue dollars/resource dollar)}$$

(2) The source-data transmission system

$$r_2 = \frac{830,859,000}{34 \times 256 \times 8} = 11,932 \qquad \text{(revenue dollars/resource dollar)}$$

$$R_2 = \frac{830,859,000}{1,312,000} = 633 \qquad \text{(revenue dollars/resource dollar)}$$

From the productivity measures computed above for each system, the productivity improvement by the system conversion is computed as follows:

(1) Improvement in revenue per manhour

$$\frac{r_2 - r_1}{r_1} = \frac{11,932 - 4,\ 526}{4,526} = +164\%$$

(2) Improvement in revenue per resource dollar

$$\frac{R_2 - R_1}{R_1} = \frac{634 - 524}{524} = +21\%$$

As in Case 1, the system conversion resulted in a great increase of 164% in output per manhour, whereas it produced a modest increase of 21% in output per resource dollar. However, if other improvements, such as reduction in stock-out items and faster delivery, were to be considered, the new system had brought about a substantial overall benefit.

Conclusion

Sales order processing is one of the office functions given priority consideration for computerization at many firms. Over the past 30 years, computerized order processing systems have gone through evolutionary changes as they have incorporated in their design advances made in information processing technology. The evolution may be divided into four main stages on the basis of how order data are prepared and entered into the computer system.

The efficiency of the order processing function may be measured by productivity indexes representing the revenue, particularly value-added revenue, per unit of its input. With these measures, one can evaluate the impact of a new information system on the efficiency of an office function or compare the efficiencies of the same office function of different firms. To illustrate the application of these measures, this paper has presented two cases on order-processing system conversion.

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Table 1

Manual or Computer-Related Operations
in Four Evolutionary Stages of Sales Order Processing Function

Operation	Stage 1 Manual order processing	Stage 2 Off-line data preparation	Stage 3 On-line data entry	Stage 4 Data entry at sources
Sales orders are sent by customers	manual	manual	manual	computer
Sales orders are received	manual	manual	manual	computer
Data on sales orders are transcribed on order forms	manual	manual	manual	--
Data are keyed onto machine readable media	--	manual	computer	--
Data are put into computer system	--	computer	--	--
Inventories are checked and shipping orders are produced	manual	computer	computer	computer
Shipping orders are sent to the warehouse	manual	manual	computer	computer

Table 2

Order Processing Personnel--Case 1

Section	Number of Personnel: Manual-Batch System	Outcome System	Change in Number
1. Sales Division			
Customers Stations	154	103	-51
Trainees	13	10	- 3
Memo Group	13	7	- 6
Review and Dispatch Group	36	11	-25
Control Group	13	12	- 1
Telephone Exchange	16	13	- 3
Contingency Staff	-	10	+10
Total	245	166	-79
2. Computer Center			
Keypunch Operation	14	0	-14
Control Clerk	1	0	- 1
Total	15	0	-15
3. Total Direct Labor	260	166	-94

Table 3

Capitalized Cost of Online System Development--Case 1
(1974 dollars)

Item	
1. Capital Facilities	
a. Equipment (Disk packs)	$ 20,000
b. Installation (computer mainframe, terminal equipment, telephone equipment, and conduit and electrical wiring)	122,000
c. Remodeling (Customer Service Department, and Data Processing Center)	574,000
d. Furniture and training equipment	65,000
Total Capital Facilities	$ 781,000
2. System Development and Implementation	
a. Manual system development and training personnel	$ 230,000
b. Information system development, conversion, implementation testing and past implementation study	962,000
c. Other training	23,000
Total System Development	$1,215,000
3. Total Capitalization Cost	$1,996,000

Table 4

Annual Operating Costs--Case 1
(1974 dollars)

Item	Manual-Batch System	Online System
1. Computer Equipment		
a. Lease Cost	$ 652,980	$1,137,192
b. Maintenance	98,784	178,476
c. Sales Tax	26,472	49,308
d. Personal Property Tax	40,752	75,912
Total	$ 818,988	$1,440,888
2. Other Equipment		
a. Microfiche Machine	$ 16,000	$ 30,000
b. Telephone-call Distributors	75,050	17,050
c. Keypunch Equipment	12,000	--
d. Teletype Equipment	5,000	--
Total	$ 108,050	$ 47,050
3. Labor		
a. Customer Relations Department	$3,267,810	$2,214,108
b. Computer Center (applicable to order processing)	147,750	34,750
Total	$3,415,560	$2,248,858
4. Forms and Supplies	$ 62,300	$ 19,300
5. Total Annual Cost ((1) + (2) + (3) + (4))	$4,404,898	$3,756,096

Table 5

Order Processing and Distribution Management--Case 1

Section	Online Data-Entry System	Source Data Transmission System	Change
	Number of Personnel		
1. Sales and Distribution:			
Order-writing Clerks	21	3	-18
Accounting-receivable Clerks	14	7	- 7
Distribution Operations Clerks	12	17	+ 5
Distribution Planning Clerks	0	3	+ 3
Supervisors	4	4	0
Total	51	34	-17
2. Data Entry:			
Keying Clerks	13	--	-13
3. Total	64	34	-30

Table 6

Annual Revenues and Costs Under Two Systems[1]--Case 1
(Units in Thousands of 1981 Dollars)

1.	Data on the online data-entry system in 1975[2]			
	(1)	Gross revenue	$593,234	
	(2)	Annual personnel cost		
		a. Order processing and distribution operations		
		40 junior clerks @ $9.43/yr.	$377	
		7 senior clerks @ $14.14 yr.	99	
		4 supervisors @ $16.76/yr.	67	
		Total	$543	
		b. Keying operations		
		13 keying clerks @ $9.43/yr.	$122	
		c. Total labor costs		$ 665
	(3)	Annual cost of EDP Center		
		a. Computer hardware lease	$1,638	
		b. Data transmission	220	
		c. Personnel	481	
		d. Total cost of EDP	$2,339	
		e. 20% applicable to order processing		468
		System development (completely written off)		0
				$1,133
2.	Data on the source-data transmission system			
	(1)	Gross revenue	$830,859	
	(2)	Annual personnel cost in order processing and distribution management		
		16 junior clerks @ $13.67	$219	
		14 senior clerks @ $19.53	273	
		4 supervisors @ $23.44	94	
		Total personnel costs		$ 586

(3)	Annual Cost of EDP Center		
	a. Computer hardware lease	$1,781	
	b. Data transmission	220	
	c. Personnel	363	
	d. Total	$2,364	
	e. Applicable to order processing[3] (16.9%)		$ 400
(4)	Annual cost of system maintenance and operation		
	System maintenance		
	4 programmers @ $16.60	$ 66	
	Data transmission	117	
			183
(5)	System development		
	System analysis and design	$ 283	
	Programming	199	
	Total	$ 482	
	Annualized cost[4] (29.6%)		$ 143
(6)	Total annual cost ((2) + (3) + (4) + (5))		$1,312

[1] All dollar values have been converted from Japanese yens at an exchange rate of $1 to 235 yens, a typical rate in 1981.

[2] All 1975 money values have been adjusted to values in 1981 price levels with Average Wholesale Price Index.

[3] The order processing application used an average of 16.9% of the total CPU time.

[4] A multiplier of 0.296 represents the capital recovery factor for a period of 6 years at a discount rate of 19.3%, the firm's average rate of return on equity capital before tax during the period of 1976-1981.